Geometry of High Energy Nuclear Collisions at RHIC

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We have investigated geometrical aspects of nuclear collisions in STAR at RHIC using the standard Glauber formalism[1].

The propagation of fast partons (jets) in dense matter has received considerable theoretical attention as a promising tool to probe the collision zone in high energy nuclear collisions. Approximate rates for the production of high transverse momentum hadrons detectable in the STAR detector were estimated by scaling high p_T hadron production cross sections measured in p-pbar collisions at $\sqrt{s}$=200 GeV to nuclear collisions, using a Woods-Saxon form for the nuclear density and assuming no nuclear shadowing. The table shows the number of events required to attain 1000 high p_T charged pions in a 1 GeV bin in the STAR TPC, for the colliding systems under discussion for early running at RHIC. Also shown is the number of days needed to accumulate these data sets, given Year 1 running conditions in STAR. It is clear from the table that high p_T physics is a statistically feasible physics program in the first year of STAR, enabling detailed study of the propagation of jets in dense matter early in the RHIC program.

System	P_T (GeV)	#event for 1000/GeV	#days
Au+Au central	5, 8	10^4, $2x10^5$	0.25, 5
Au+Au minbias	5, 8	$4x10^4$, $8x10^5$	0.05, 1
Si+Si central	5, 8	$1.5x10^5$, $3x10^6$	0.6, 12
Si+Si minbias	5, 8	$5x10^5$, $1x10^7$	0.1, 2
p+p minbias	5, 8	$1x10^7$, $2x10^8$	2, 40

High momentum transfer interactions such as jet or charm production are attractive probes of nuclear matter, since their production rates are perturbatively calculable given sufficient knowledge of the initial state of the system (including nuclear shadowing). The spatial distribution of such interactions within the reaction zone of colliding nuclei is dominated by nuclear geometry. The figure shows the mean and dispersion of the radial distance of interactions in the plane transverse to the direction of the incoming nuclei, as a function of impact parameter for Au+Au collisions. "Wounded Nucleon" and "Binary Collisions" correspond to processes in the nuclear collision with large and small nucleon-nucleon cross sections, whereas "Two Dimensional" and "Hard Sphere" correspond to collisions of disks and billiard balls. It is seen that for central collisions, hard processes occur on average over 3 fm from the center of the collision zone, with rather few hard collisions occurring in the center of the zone, simply due to phase space.

Footnotes and References

1. P. Jacobs and G. Cooper, STAR Note SN0402.